AMSTERDAM INTERNATIONAL WATER WEEK

Study employed a computer model and satellite remote sensing to evaluate the temporal and spatial distribution of snow in the western Hindu Kush region, Afghanistan

Shafiqullah Noori

JICA Schalor

08/11/2023

Introduction

- Millions of people reside downstream of river basins that heavily rely on snowmelt originating from the Hindu Kush (HK) region. Snowmelt plays a critical role as a primary water source in these areas.
- In mountainous regions, snowfall is temporarily cumulative during the winter due to topographical factors including elevation, slope, aspect, exposure, and low temperature. Meltwater is released from snow-dominated areas in the spring-summer melt season.
- The Maidan Shahr watershed (Fig. 1) is in the northeastern part of Maidan Wardak province of Afghanistan and is surrounded by the range of a high, steep mountainous HK mountain.

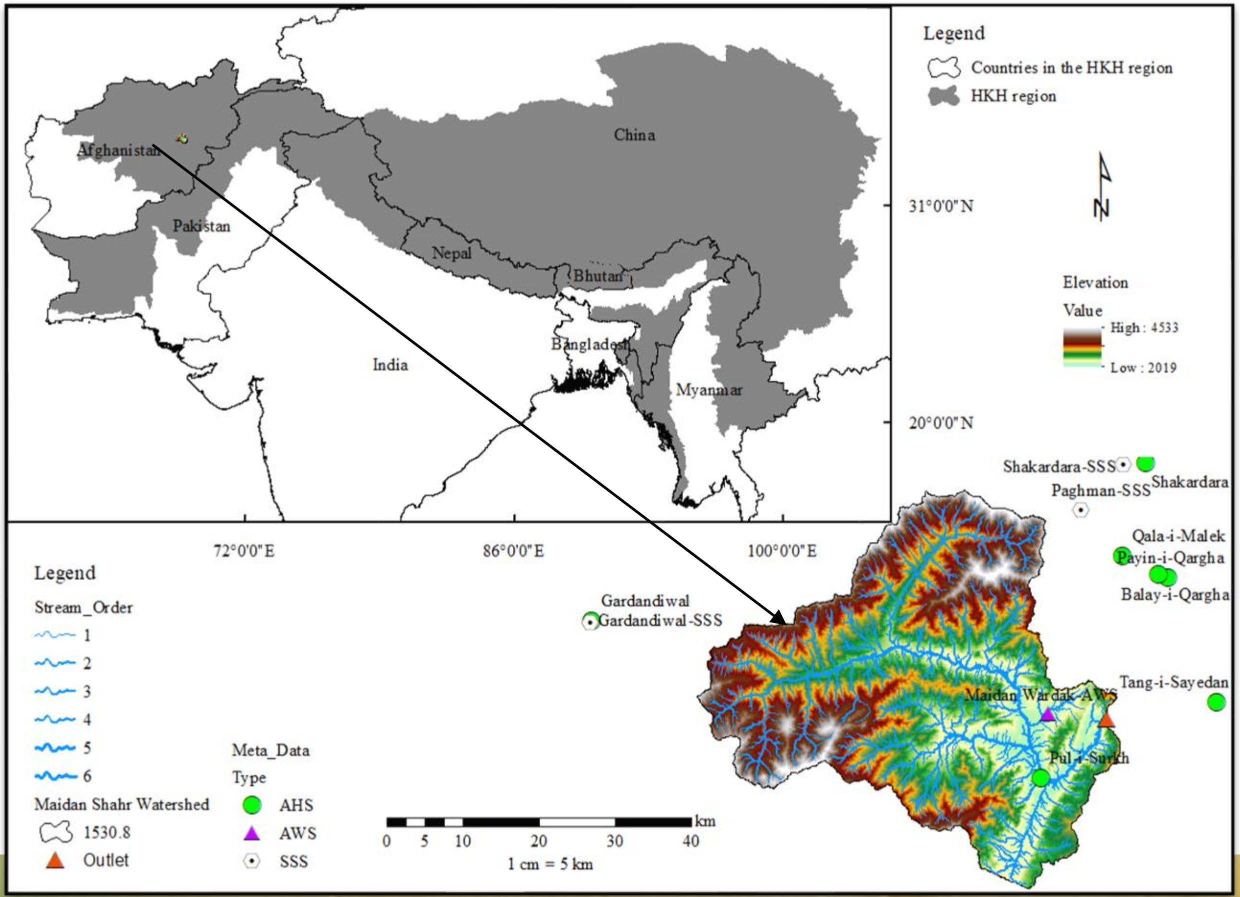

Fig. 1 Map of the Hindu Kush Himalayan region, Maidan Shahr watershed location.

Methodology

- The goal of this study was to estimate the SWE, snowfall, and snowmelt characteristics in a watershed in the western HK region. Including the use of the improved MODIS product and observed data. Optimizing model parameters, and assessing the simulated SCA and improved MODIS SCA
- This method requires information about the duration of snow cover, it is applicable after the snow disappears, and is useful for reconstructed SWE distributions with the SM and melt-runoff analysis.
    - Degree-Day Factor (DDF)

$$M_s = \begin{cases} DDF(T_a - T_b), & T_a > T_b \\ 0, & T_a \le T_b \end{cases}$$

$$\sum_{t=1}^{SDD} SF_t = \sum_{t=1}^{SDD} (DDF \times T_{a,t})$$

- Snow Model (SM)

$$SWE_{t+1} = SWE_t + SF_t + M_{s,t}$$

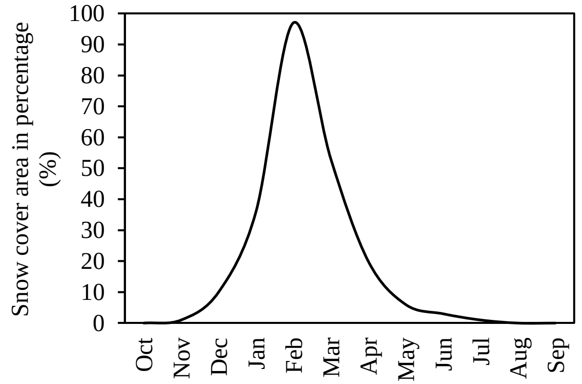

Fig. 2 The improved MODIS snow-cover product provided monthly snow cover percentages from 01/Oct/2014 to 30/Sep/2017.

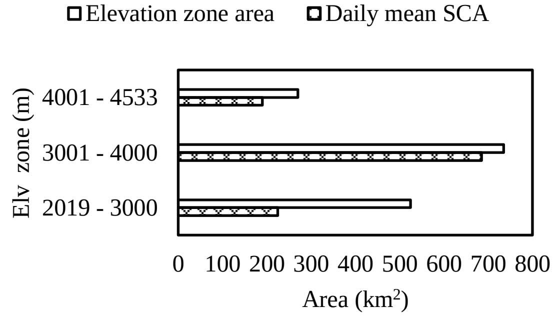

Fig. 3 The improved MODIS snow-cover product provided a daily snow-cover area in the elevation zone from 01/Oct/2014 to 30/Sep/2017.

Model Experiments

- To identify the SM in the study area, some parameters such as temperature lapse rate, critical temperature, DDF, and PG were required to run the model.
- Among these parameters, I calculated the lapse rate using available observed hydrological data from within and near the study area, and we found a value of -7.0 °C km-1. The critical temperature was assumed of 2.0 °C.

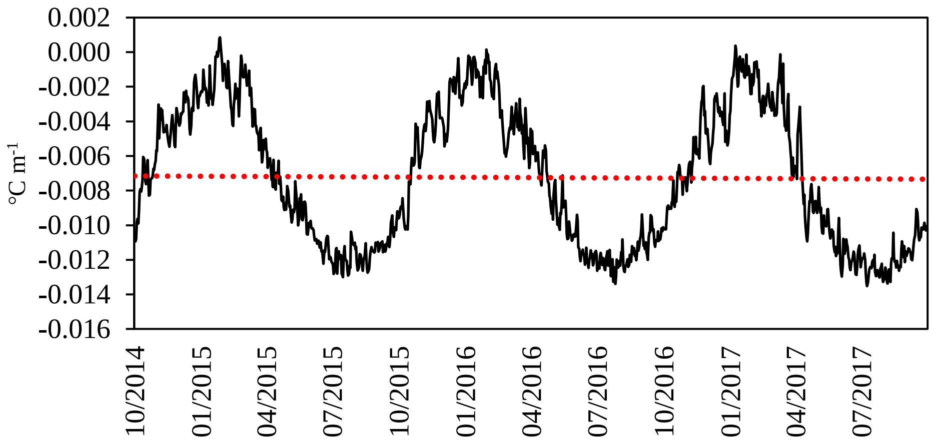

Fig. 4 The red dot line represents the mean value of daily-based lapse rate over periods (01/Oct/2014 - 30/Sep/2017).

Model Experiments

- I conducted twenty experiments for different DDF values (1, 3, 5, and 7) (mm °C-1 d-1), and PG values (-0.002, -0.001, 0, 0.001, and 0.002) (m-1) to determine the appropriate values for these two parameters for the calibration period, positive values represent an increase in precipitation with elevation, while negative values represent a decrease in precipitation with elevation.

Coefficient of determination (R2) among simulated SCA and improved MODIS SCA time series. Bold numbers are assumed to be significant with more than 0.9.

DDF (mm °C^{-1} d^{-1})	Precipitation Gradient (m^{-1})				
	-0.002	-0.001	0	0.001	0.002
1	0.225	0.373	**0.961**	**0.932**	**0.928**
3	0.041	0.210	**0.982**	**0.952**	**0.933**
5	0.040	0.171	**0.981**	**0.972**	**0.952**
7	0.040	0.118	**0.979**	**0.983**	**0.972**

Result

- Optimized parameters of SCA.

Coefficient of determination (R2) among simulated SCA and improved MODIS SCA time series. Bold numbers are assumed to be significant with more than 0.9.

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- Simulated spatial SWE distribution.

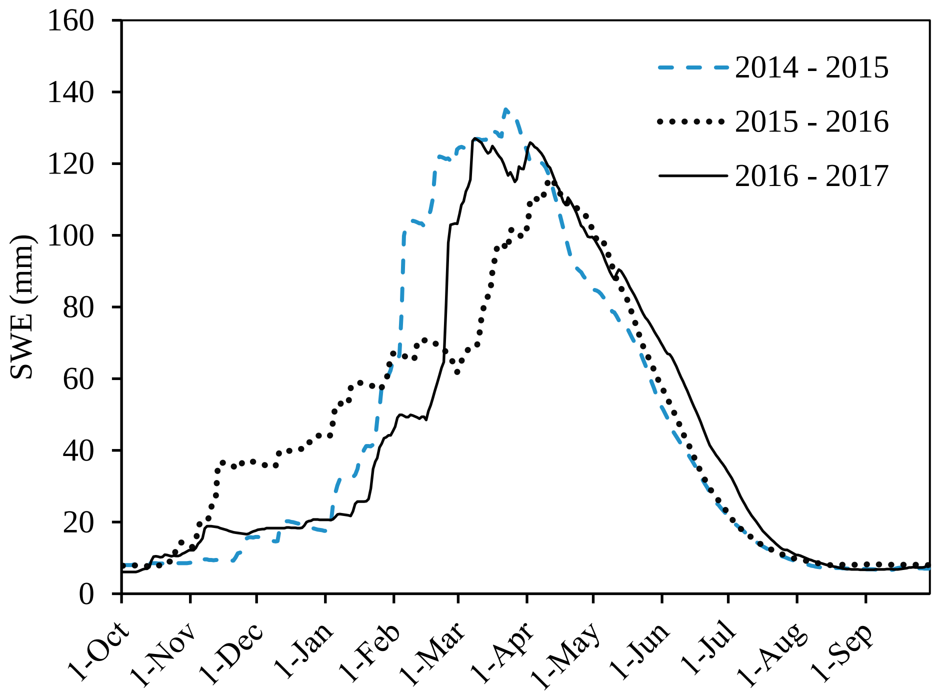

Fig. 7 Comparing SWE among the years 2014 – 2015, 2015 – 2016, and 2016 – 2017, respectively.

References

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Thank you